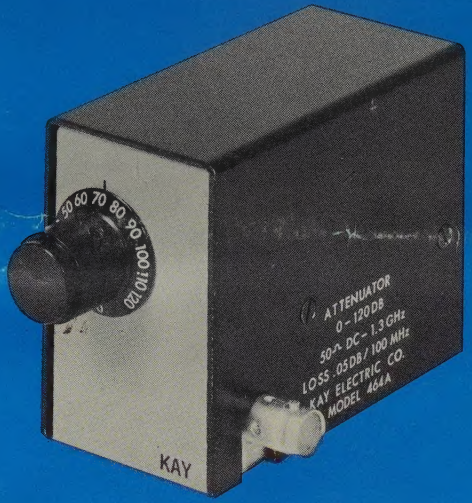
Attenuators

MODELS: 464 • 467 • 4647



KAY ELECTRIC CO.

INSTRUCTION MANUAL
ISSUE A

JULY, 1969

ATTENUATORS
MODEL 464, 467, & 4647

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KAY ELECTRIC COMPANY
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SECTION I, GENERAL INFORMATION

1.1 INTRODUCTION:

The Model 464, 467, and 4647 attenuators furnish accurate attenuation over the D.C. to 1.0 GHz frequency range. The 464 (0-120db), 467 (0-12db) and 4647 (0-132db) utilize a cam operated rotary mechanism to select the various values of attenuation. The basic attenuator is a miniature in-line unit constructed of precision resistors mounted in broad-tuned, shielded compartments.

The single units Model 464 and Model 467, as well as the combined unit Model 4647 may be easily panel mounted or used as a conventional bench top instrument.

1.2 SPECIFICATIONS:

MODEL 464

Frequency Range: DC to 1.3 GHz

Attenuation Range: 0 - 120db, 10db steps

Overall Accuracy: ±.3db at 1000 Hz
±1db to 500 MHz
±1.5db to 1.3 GHz

Maximum VSWR: 1.2:1, 0 - .5 GHz
1.5:1, .05 - 1.3 GHz

Insertion Loss: .05 db/100 MHz

Power Capability: 1 watt at 40° C

Dimensions: 1 3/4" x 3 7/16" x 2 11/16"

MODEL 467

Frequency Range: DC to 1.5 GHz

Attenuation Range: 0 - 12db, 1db steps

Overall Accuracy: ±.3db to 1 GHz
±.5db to 1.5 GHz

Maximum VSWR: 1.25:1, 1 GHz
1.5:1, 1.5 GHz

Insertion Loss: .05db/100 MHz

Power Capability: 1 watt at 40° C

Dimensions: 1 3/4" x 3 7/16" x 2 11/16"

MODEL 4647

Frequency Range: DC to 1 GHz

Attenuation Range: 0 to 132db, 1db steps

Overall Accuracy: ±2.0db to 1 GHz

Maximum VSWR: 1.5:1 to 1 GHz

Insertion Loss: .1db/100 MHz

Power Capability: 1 watt at 40° C

Dimensions: 3 1/8" x 3 1/8" x 2 5/8"

1.3 RECEIVING AND RESHIPMENT:

When the attenuator is initially received, a visual check will determine any damage that may have occured during shipment. Note particularly the connectors and the ease of operation of the rotary action. Should any damage be discovered, report it immediately to the carrier and to the Kay Electric Company.

When returning an instrument for repair or calibration, secure permission from the factory or a Kay representative before doing so. As an aid to the service personnel, the instrument model and serial number, and the particular defect should be included on the packing slip.

1.4 INSTALLATION INSTRUCTIONS:

A. BENCH TOP USE:

1. The attenuator is included in the system by providing interconnecting cables of the proper impedance, as required.
2. The units are bidirectional, so either connector may be considered the input or output.

B. PANEL MOUNTING:

1. Turn the indicator knob to the "0" db position.
2. Remove the knob and the nylon spacer.
3. Remove the front panel to expose the mounting holes.
4. The attenuator may now be installed on the panel.
5. Replace the indicator knob with "0" db in its original position.

2.1 OPERATING INSTRUCTIONS:

1. See Fig. 2.1 for typical interconnection of equipment.
2. To avoid producing supurious losses through impedance mismatch, make all connections using the proper connectors and cabling.
3. These attenuators constitute a direct DC path and do not include internal protective devices such as fuses, decoupling capacitors, etc.. To avoid damage to the precision components, signals greater than those specified should not be applied to the units.
4. Attenuation levels are selected by rotating the control knob to the desired value.
5. Care should be taken not to allow signals to be fed through the attenuator which might damage the unit being tested.

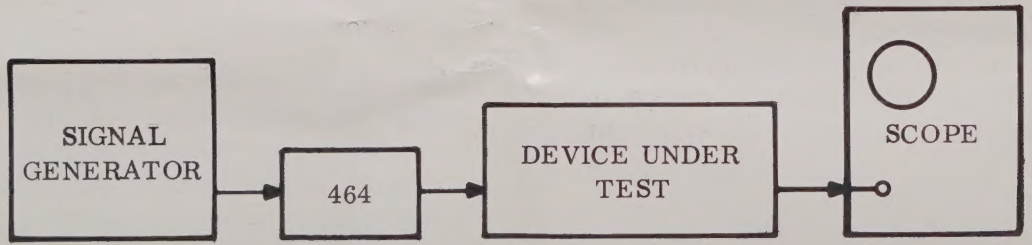


FIGURE 2.1

3.1 CIRCUIT DESCRIPTION:

Basically, an attenuator is designed to perform one function, that is, to reduce a signal from a high level to a lower one. In the case of low frequency signals, it is usually sufficient to only provide a resistive network to lower the signal. At higher frequencies it is necessary to provide a means of matching impedance between the attenuator and the test device to prevent reflected energy. For this reason, the attenuator is designed with carefully calculated values of resistance, capacitance and inductance so as to offer a balance of attenuation accuracy and impedance match. The 464, 467, and 4647 attenuators utilize a "pi" type attenuation network mounted in a broad tuned cavity. This arrangement is designed to meet the requirements of precise attenuation values and proper impedance match.

Mechanically, the attenuators are a familiar in-line device, utilizing a rotary-cam activated control system to throw the toggle switch in and out of the circuit. The mechanism has been designed so as to insure positive switch action and repeatability without affecting the attenuation accuracy.

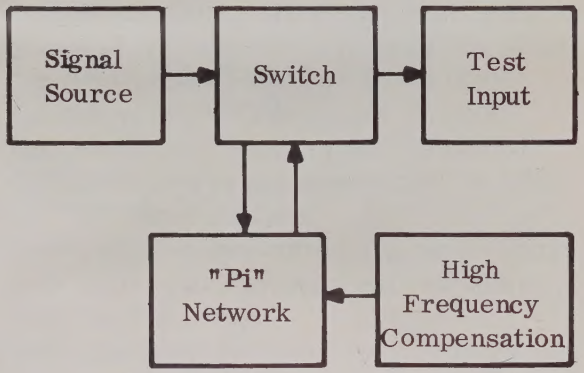


FIGURE 3.1

4.1 INTRODUCTION:

The following information is provided to permit the operator to perform a complete factory type check of the instrument's operation. These instructions will be especially helpful whenever repairs have been made or when the unit is initially received.

To insure accurate results, the test set-up should be as free as possible from stray radiation. The use of the proper impedance cables and connectors is extremely important. The connectors used should also provide a tight mechanical and electrical connection in order to prevent inaccurate readings when checking performance at the higher frequencies.

4.2 TEST PROCEDURE:

4.2.1 Equipment Required:

Oscilloscope - Tektronix Type 503 or equiv.
Loss Measure. Receiver - Kay Gain Set Mod. 625, or equiv.
Swp. Gen. - Kay Model 121C, or equiv.
Tuned Amp. & Indicator - GP Mod. 1232A, or equiv.
CW Signal Gen. - HP Model 200, or equiv.
CW Signal Gen. - GR 1209C, or equiv.
CW Signal Gen. - GR 1209B, or equiv.
CW Signal Gen. - GR 1215B, or equiv.
Standard Attenuator - Kay 461A, or equiv.
Attenuator Pads - HP Model 8491 (6db), or equiv.
Attenuator Pads - GR, 20db, 10db, or equiv.
Attenuator Pads - 3db loss, $\frac{1}{2}$ watt
Matching Transformer - 500Ω to 50K Ω
Matching Transformer - 50 to 50KΩ
VSWR Standards - 1.1:1, 1.2:1, 1.5:1
Detector - as per Figure 4.1a.
Mixer - as per Figure 4.1b.

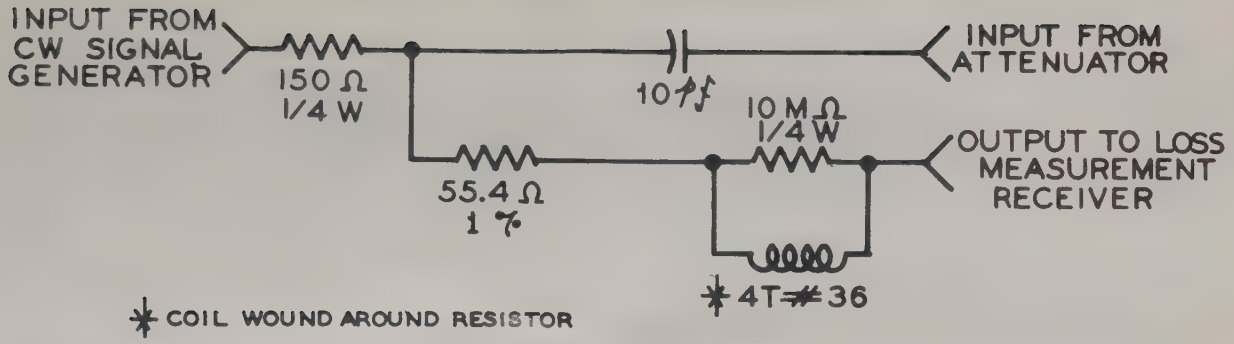


FIGURE 4.1a

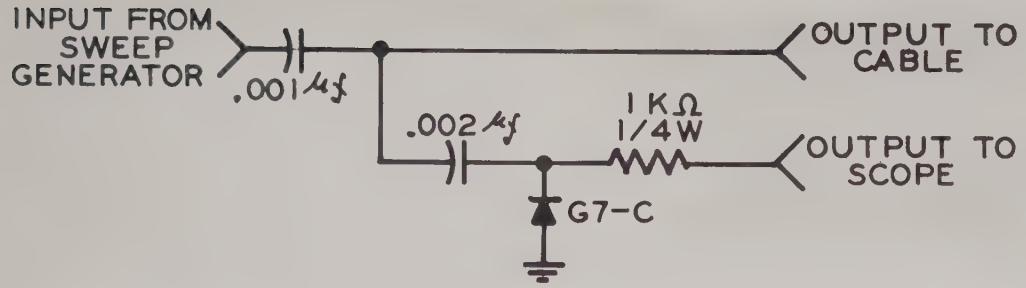


FIGURE 4.1b

4.2.2 1 KHz Check:

a. Interconnect equipment as shown in Fig. 4.2.
b. Switch 120db into the standard attenuator.
c. Switch all attenuation out of the test attenuator.
d. Adjust the HP 200 for an output of 7.7 volts into the 3db pad at 1 KHz.
e. Adjust the GR 1232A for approximately 2/3 full scale meter reading with the filter control at peak.
f. Switch 1db of attenuation into the standard attenuator and see that the 1232A reflects this change.
g. Establish a ±0.3db limit on the 1232A scale.
h. Check each position of the test attenuator by inserting a value and removing similar value from the standard attenuator.
i. See that the total error noted does not exceed the ±0.3db tolerance.

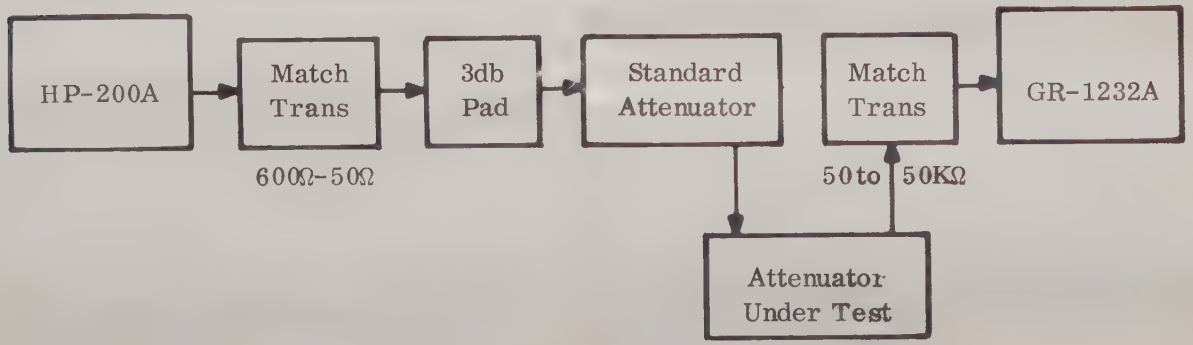


FIGURE 4.2

4.2.3 70 MHz Check:

a. Interconnect equipment as shown in Fig. 4.3.
b. Adjust the GR 1215B for an output of 70 MHz.
c. Insert 90db of attenuation into the standard attenuator.
d. Adjust the Gain Control on the GAIN SET for a zero db reading on the meter.
e. Switch 1db into the standard attenuator and see that the GAIN SET reflects this change.
f. To check the accuracy, insert a step of attenuation into the test attenuator and remove a like amount from the standard attenuator. Note the error on the GAIN SET meter.
g. The error noted should not exceed that specified for the unit.
h. Remove the 6db pads from the test set up.
i. Insert 120db into the standard attenuator. Reset GAIN SET.
j. Check the 100, 110, and 120db positions of the test attenuator by substituting with the standard.
k. See that the error noted is within specification.

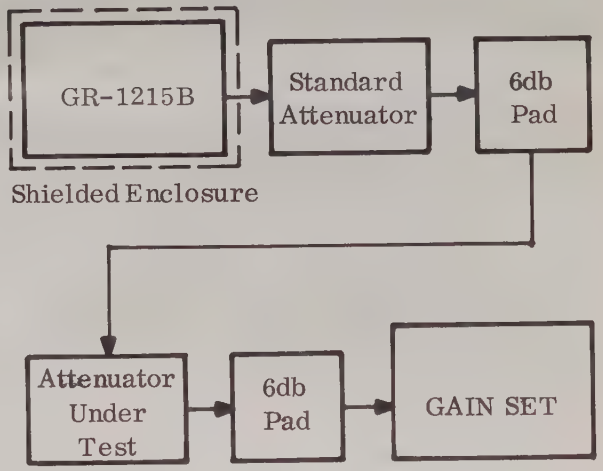


FIGURE 4.3

4.2.4 70 MHz Insertion Loss Check:

a. Interconnect equipment as shown in Fig. 4.4.
b. Remove all attenuation from the test attenuator.
c. Adjust the GAIN SET for a 0 db reading at 70 MHz output from the GR 1215B.
d. Remove the test attenuator from the system and substitute a feedthru connector for it.
e. The insertion loss may now be read diectly from the GAIN SET meter.

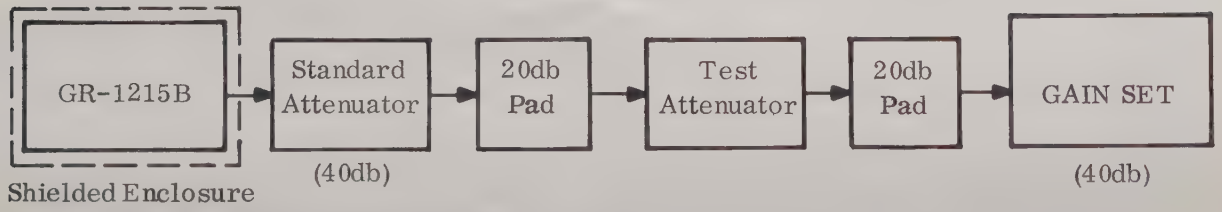


FIGURE 4.4

4.2.5 500 MHz Check (0-90db)

a. Interconnect equipment as shown in Fig. 4.5 with Test Attenuator at zero.
b. Switch 90db into the standard attenuator.
c. Adjust one GR 1209B for a 500 MHz output.
d. Adjust the other 1209B for a peak reading on the GAIN SET meter.
e. Zero the GAIN SET meter.
f. Remove attenuation from the standard attenuator and substitute a like value in the test unit.
g. See that the error is within specification.
h. Remove the 6db pads, set standard attenuator to 120db, zero gain set with test attenuator on zero. Switch to 100, 110, 120, db removing appropriate steps from standard attenuator and note errors.

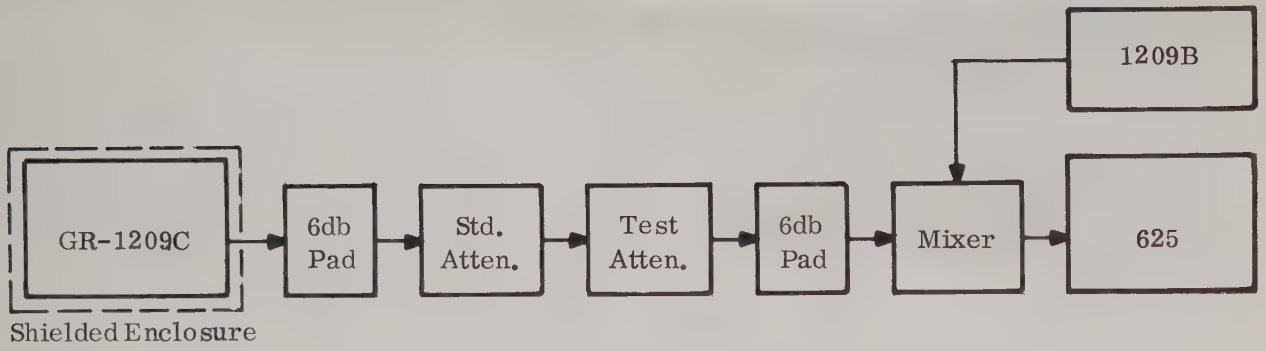


FIGURE 4.5

4.2.6 1 GHz Check (0-90db)

a. Interconnect equipment as shown in Fig. 4.6.
b. Switch 90db into the standard attenuator.
c. Set the 464 for zero attenuation.
d. Adjust the GR 1209B for 1 GHz output.
e. Adjust the GR 1209B for a convenient reading on the Kay 625.
f. Using the standard attenuator, determine the 1.5db limits as observed on the 625.
g. Using both the standard attenuator and the test attenuator, substitute attenuation and check to see that each position is within specifications.

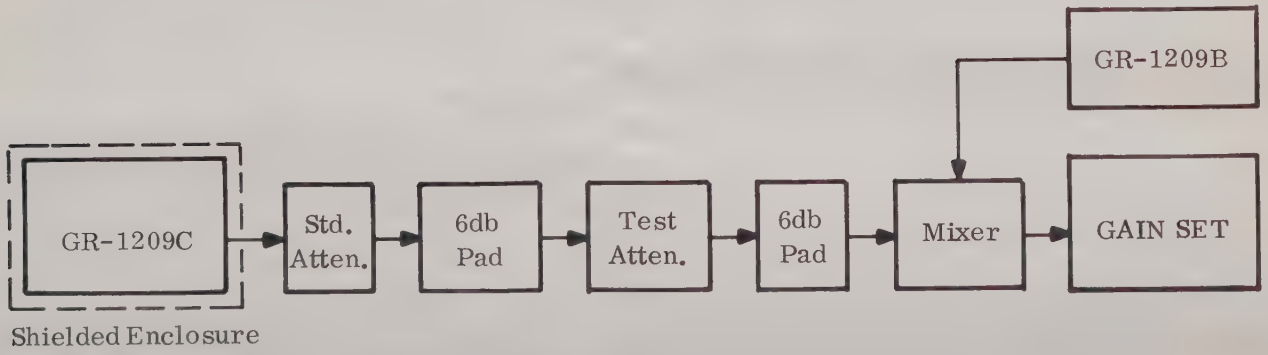


FIGURE 4.6

4.2.7 1 GHz Check (90-120db)

a. Interconnect equipment as shown in Fig. 4.7.
b. Switch 120db into the standard attenuator.
c. Switch all attenuation out of the test attenuator.
d. Adjust the GR 1209C for 1 GHz output.
e. Adjust the GR1209B for a convenient reading on the Kay 625.
f. Determine the 3.0db limits on the Kay 625, by using the standard attenuator.
g. Check the 100, 110, and 120db positions of the test attenuator by substitution with the standard attenuator.
h. See that the error is within specification.

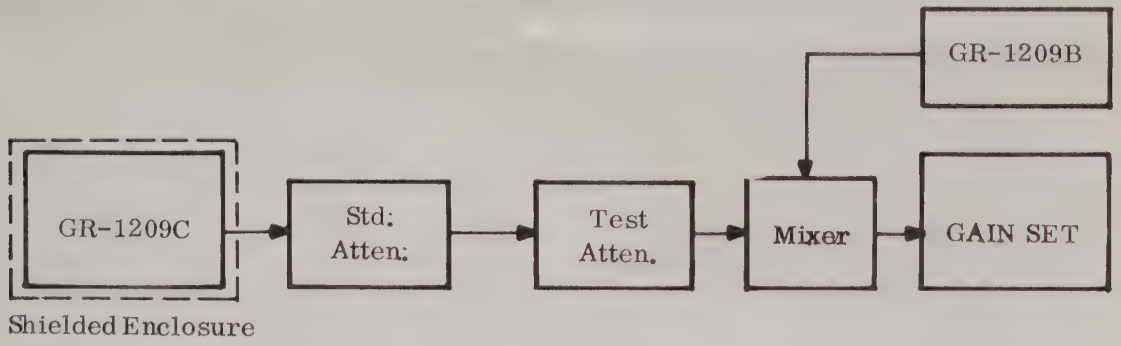


FIGURE 4.7

4.2.8 1 GHz Insertion Loss Check:

a. Interconnect the equipment as shown in Fig. 4.8.
b. Remove all attenuation from test attenuator.
c. Adjust the GR 1209C for an output of 1 GHz.
d. Adjust the GR 1209B for an output of 930 MHz for peak on GAIN SET.
e. Zero the GAIN SET meter.
f. Remove the test attenuator and substitute a feedthru connector for it.
g. The insertion loss may now be read directly from the GAIN SET meter.

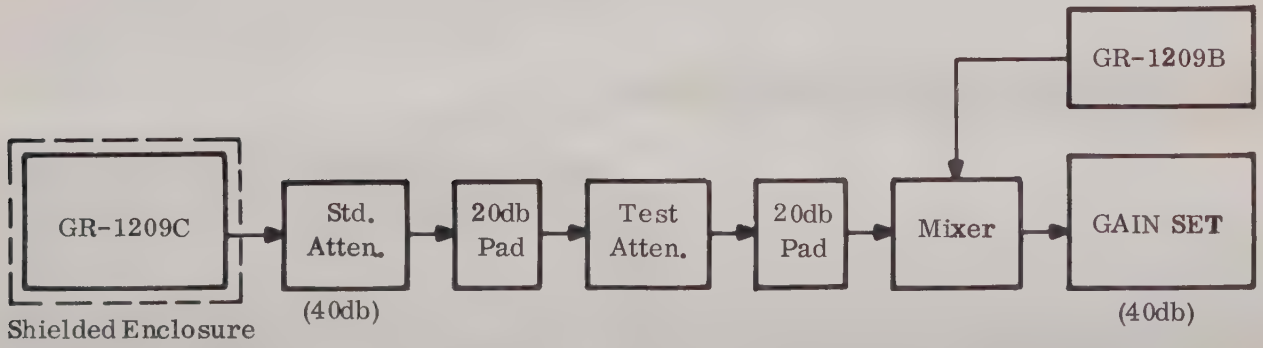


FIGURE 4.8

4.2.9 VSWR Check:

1. a. Interconnect equipment as shown in Fig. 4.9.
   b. Tune the output frequency of the 121C to point of greatest mismatch.
   c. Establish a scope reference scale (such as 1 cm = 1).
   d. Adjust the vertical gain of the scope so that the vertical distance between the baseline and the negative peaks of the standing wave (dimension A, Fig. 4.10) is equal to the reference scale.
   e. Determine the distance between the baseline and the positive peaks of the standing wave (dimension B, Fig. 4.10) is equal to the reference scale.
   f. The VSWR will be equal to the deflection obtained in 4.2.9e divided by the reference established in 4.2.9c. VSWR should equal that stated in specifications of unit under test.
2. a. Interconnect as in Fig. 4.9.
   b. Substitute a known mismatch for the attenuator (available as 1:2:1, 1:5:1, etc.) Note the VSWR on the oscilloscope.
   c. Replace the attenuator in the test setup.
   d. The attenuator should not exceed the specified VSWR.
3. If equipment for performing the previous checks is not available, a slotted line and appropriate techniques will provide acceptable results.

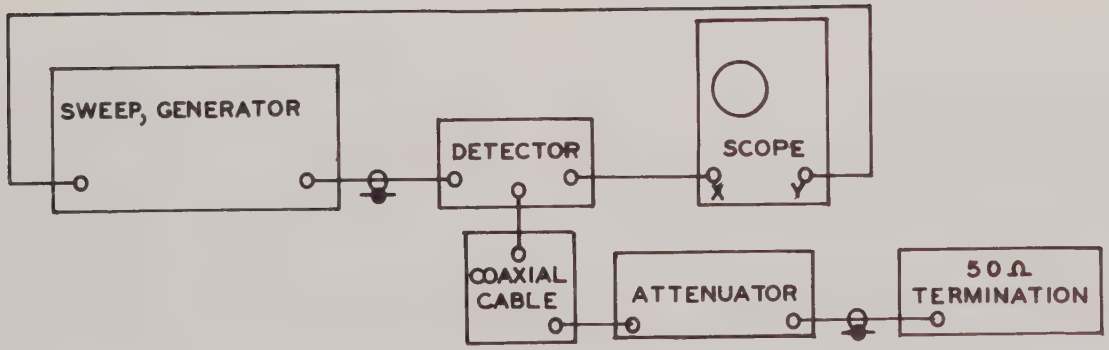


FIGURE 4.9

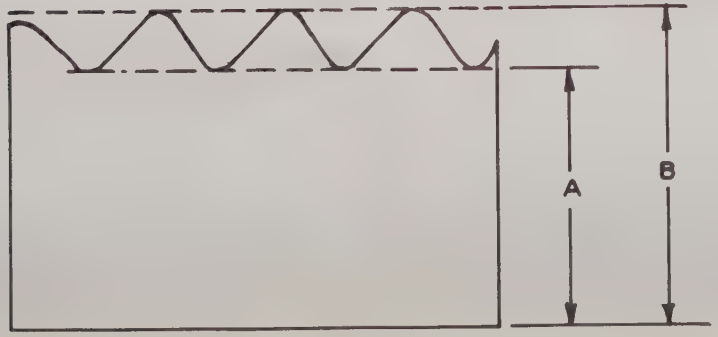


FIGURE 4.10

4.3 TEST PROCEDURE, Model 467

4.3.1 EQUIPMENT REQUIRED:

Oscilloscope - Tektronix Type 503 or equiv.
Loss Measurement Receiver - Kay Gain Set Model 625, or equiv.
Sweep Gen. - Kay Model 121C, or equiv.
Tuned Amplifier & Indicator - GP Model 1232A, or equiv.
CW Signal Gen. - HP Model 200, or equiv.
CW Signal Gen. - GR 1209C, or equiv.
CW Signal Gen. - GR 1209B, or equiv.
CW Signal Gen. - GR 1215B, or equiv.
Attenuator Pads - HP Model 8491 (6db), or
Attenuator Pads - GR, 20db, 10db, or equiv.
Attenuator Pads - 3db loss, $\frac{1}{2}$ watt
Matching Transformer - 600Ω to 50Ω
Matching Transformer - 50 to 50KΩ
VSWR Standards - 1.1:1, 1.2:1, 1.5:1
Detector - as per Figure 4.1a
Mixer - as per Figure 4.1b

4.3.2 1 KHz CHECK:

a. Interconnect equipment as shown in Fig. 4.2.
b. Switch 12db into the standard attenuator.
c. Switch all attenuation out of the test attenuator.
d. Adjust the HP 200 for an output of 7.7 volts into the 3db pad at 1 KHz.
e. Adjust the GR 1232A for approximately 2/3 full scale meter reading with the filter control at peak.
f. Switch 1db of attenuation into the standard attenuator and see that the 1232A reflects this change.
g. Establish a ±0.3db limit on the 1232A scale.
h. Check each position of the test attenuator by inserting a value and removing a similar value from the standard attenuator.
i. See that the total error noted does not exceed the ±0.3db tolerance.

4.3.3 70 MHz CHECK:

a. Interconnect equipment as shown in Fig. 4.3.
b. Adjust the GR 1215B for an output of 70 MHz.
c. Insert 12db of attenuation into the standard attenuator.
d. Adjust the Gain Control on the GAIN SET for a zero db reading on the meter.
e. Switch 1db into the standard attenuator and see that the GAIN SET reflects this change.
f. To check the accuracy, insert a step of attenuation into the test attenuator and remove a like amount from the standard attenuator. Note the error on the GAIN SET meter.

4.3.4 70 MHz INSERTION LOSS CHECK:

a. Interconnect equipment as shown in Fig. 4.4.
b. Remove all attenuation from the test attenuator.
c. Adjust the GAIN SET for a 0db reading at 70 MHz output from the GR 1215B.
d. Remove the test attenuator from the system and substitute a feedthru connector for it.
e. The insertion loss may now be read directly from the GAIN SET meter.

4.3.5 500 MHz CHECK:

a. Interconnect equipment as shown in Fig. 4.5 with test attenuator at zero.
b. Switch 12db into the standard attenuator.
c. Adjust one GR 1209B for a 500 MHz output.
d. Adjust the other 1209B for a peak reading on the GAIN SET meter.

4.3.6 1 GHz CHECK:

a. Interconnect equipment as shown in Fig.

4.6.

b. Switch 12db into the standard attenuator.
c. Set the test attenuator for zero attenuation.
d. Adjust the GR 1209C for 1 GHz output.
e. Adjust the GR 1209B for a convenient reading on the Kay 625.
f. Using the standard attenuator, determine the 1.5db limits as observed on the 625.
g. Using both the standard attenuator and the test attenuator, substitute attenuation and check to see that each position is within specifications.

4.3.7 1 GHz INSERTION LOSS CHECK:

a. Interconnect the equipment as shown in Fig. 4.8.
b. Remove all attenuation from test attenuator.
c. Adjust the GR 1209C for an output of 1 GHz.
d. Adjust the GR 1209B for an output of 930 MHz and peak the GAIN SET meter.
e. Zero the GAIN SET meter.
f. Remove the test attenuator and substitute a feedthru connector for it.
g. The insertion loss may now be read directly from the GAIN SET meter.

4.3.8 VSWR CHECK:

1.a. Interconnect equipment as shown in Fig. 4.9.
b. Tune the output frequency on the 121C to point of greatest mismatch.
c. Establish a scope reference scale (such as 1cm = 1).
d. Adjust the vertical gain of the scope so that the vertical distance between the baseline and the negative peaks of the standing wave (dimension A, Fig. 10) is equal to the reference scale.
e. Determine the distance between the baseline and the positive peaks of the

standing wave (dimension B, Fig. 4.10) using reference scale.

f. The VSWR will be equal to the deflection obtained in 4.2.9e divided by the reference scale.

2.a. Interconnect as in Fig. 4.9.

b. Substitute a known mismatch for the attenuator (available as 1:2:1, 1:5:1, etc.). Note the VSWR on the oscilloscope.

c. Replace the attenuator in the test set-up.

d. The attenuator should not exceed the specified VSWR.

3. If equipment for performing the previous checks is not available, a slotted line and appropriate techniques will provide acceptable results.

4.4 TEST PROCEDURE, Model 4647:

4.4.1 In order to facilitate testing of the 4647, it is suggested that the procedures for the 464 and 467 are followed for all accuracy checks.

Insertion loss and VSWR checks may be made in the normal fashion outlined for the single units.

PARTS LIST - ATTENUATOR MODEL 464A, DWG. NO A10673-B

DWG. SYMBOL NO.	DESCRIPTION	KAY PART NO.	MANUFACTURER & PART NO.
CAPACITORS:			
C1	.75 μμf, ceramic	6361-37	Quality Component QC .75
C2 thru C10	Not Used		
C11	.3 μμf, ceramic	6361-40	Quality Component QC .3
C12	.68 μμf, ceramic	6361-61	Quality Component QC .68
C13 & C14	Not Used.		
CONNECTORS:			
J1	Coax, UG290/U modified	11148	Kay Electric Co.
J2	Coax, UG290/U modified	11148	Kay Electric Co.
RESISTORS: (Unless otherwise specified, all components are fixed composition, 1% tolerance, $\frac{1}{4}$ watt)			
R1	122.2	6558-170	Mepco Type C10-122.2
R2	122.2	6558-170	Mepco Type C10-122.2
R3	122.2	6558-170	Mepco Type C10-122.2
R4	122.2	6558-170	Mepco Type C10-122.2
R5	248	6558-98	Mepco Type C10-248
R6	106.53	6558-166	Mepco Type C10-106.53
R7	106.53	6558-166	Mepco Type C10-106.53
R8	106.53	6558-166	Mepco Type C10-106.53
R9	106.53	6558-166	Mepco Type C10-106.53
R10	790	6558-96	Mepco Type C10-790
R11	106.53	6558-166	Mepco Type C10-106.53
R12	Not Used		
R13	106.53	6558.166	Mepco Type C10-106.53
R14	106.53	6558.166	Mepco Type C10-106.53
R15	790	6558-96	Mepco Type C10-790
R16	106.53	6558-166	Mepco Type C10-106.53
R17	106.53	6558-166	Mepco Type C10-106.53

R18	106.53	6558-166	Mepco Type C10-106.53
R19	106.53	6558-166	Mepco Type C10-106.53
R20	790	6558-96	Mepco Type C10-790
R21	96.15	6558-99	Mepco Type C10-96.15
R22	96.15	6558-99	Mepco Type C10-96.15
R23	71.17	6558-99	Mepco Type C10-96.15
R24	106.53	6558-166	Mepco Type C10-106.53

SWITCHES:

S1	Switch, Toggle DPDT	254-TM	Kay Electric Co.
S2	Switch, Toggle DPDT	254-TM	Kay Electric Co.
S3	Switch, Toggle DPDT	254-TM	Kay Electric Co.
S4	Switch, Toggle DPDT	254-TM	Kay Electric Co.
S5	Switch, Toggle DPDT	254-TM	Kay Electric Co.

PARTS LIST ATTENUATOR MODEL 467A, DWG. NO A11112

CAPACITORS:

C30 thru C41	Factory Selected		

CONNECTORS:

J3 & J4	Coax, UG290/U modified	11148	Kay Electric Co.

COILS:

L10 thru L14	Factory Selected		

RESISTORS: (Unless otherwise specified, all components are fixed composition, 1% tolerance, $\frac{1}{4}$ watt)

R30 & R31	436.1	6558-186	Mepco Type C10-436.1
R32	11.62	6558-131	Mepco Type C10-11.62
R33 & R34	292	6558-101	Mepco Type C10-292
R35	17.63	6558-102	Mepco Type C10-17.63

DWG. SYMBOL NO.	DESCRIPTION	KAY PART NO.	MANUFACTURER & PART NO.
R36 & R37	292	6558-101	Mepco Type C10-292
R38	17.63	6558-102	Mepco Type C10-17.63
R39 & R40	292	6558-101	Mepco Type C10-292
R41	17.63	6558-102	Mepco Type C10-17.63
R42 & R43	863	6558-189	Mepco Type C10-863
SWITCHES:			
S10 thru S14	Switch, Toggle DPDT	254-TM	Kay Electric Co.

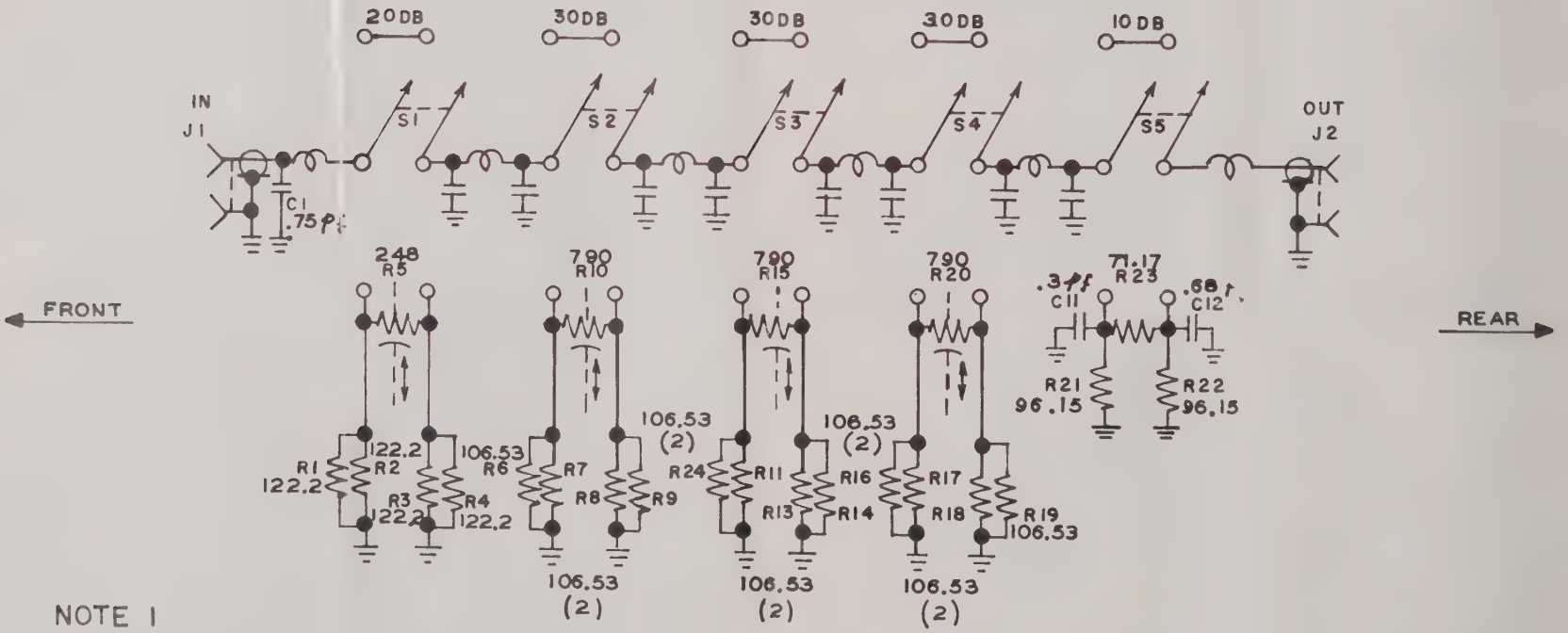
PARTS LIST ATTENUATOR MODEL 4647A, DWG. NO B11389A

CAPACITORS:	Factory Selected		
C41 thru C63	Factory Selected		
CONNECTORS:			
J5 & J6	Coax, UG290/U, modified	11148	Kay Electric Co.
COILS:			
L40 thru L45	Factory Selected		

RESISTORS: (Unless otherwise specified, all components are fixed composition, 1% tolerance, $\frac{1}{4}$ watt)

R40 thru R43	122.2	6558-170	Mepco Type C10-122.2
R44 thru R55	106.53	6558-166	Mepco Type C10-106.53
R56 & R57	96.15	6558-99	Mepco Type C10-96.15
R58 & R59	436.1	6558-186	Mepco Type C10-436.1
R60 thru R65	292	6558-101	Mepco Type C10-292
R66 & R67	863	6558-189	Mepco Type C10-863
R68	248	6558-98	Mepco Type C10-248
R69 thru R71	790	6558-166	Mepco Type C10-790

R72	71.17Ω	6558-99	Mepco Type C10-71.17
R73	11.62	6558-131	Mepco Type C10-11.62
R74 thru R76	17.63	6558-102	Mepco Type C10-17.63
R77	5.81	6558-124	Mepco Type C10-5.81
SWITCHES:			
S40 thru S49	Toggle, DPDT	254-TM	Kay Electric Co.



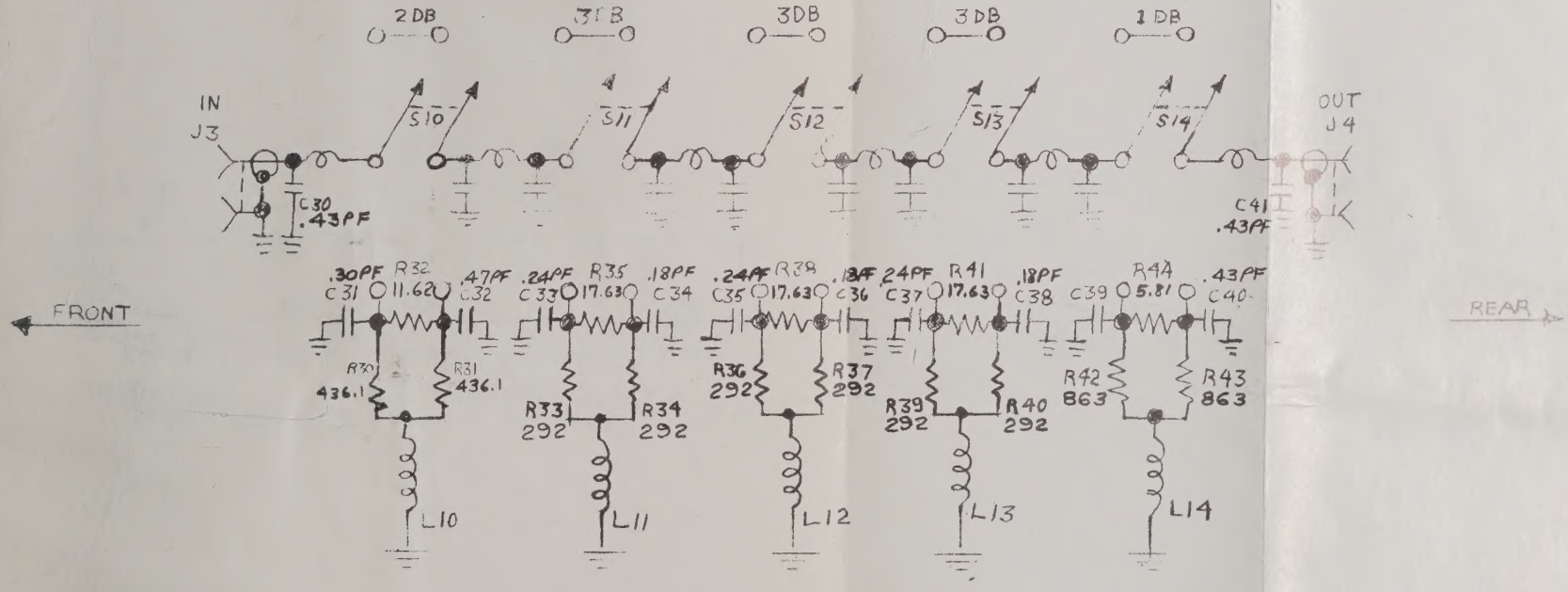
NOTE 1

SCHEMATIC FOR ATTENUATOR
MODEL NO 464 A 50 Ω 0 INSERTION LOSS

NOTE 2

CAVITY INDUCTANCE & CAPACITANCE INDICATED

DWG. NO. 10673, ATTENUATOR MODEL 464A



NOTE 1

SCHEMATIC FOR ATTENUATOR
MODEL NO 467 A 50Ω 0 INSERTION LOSS

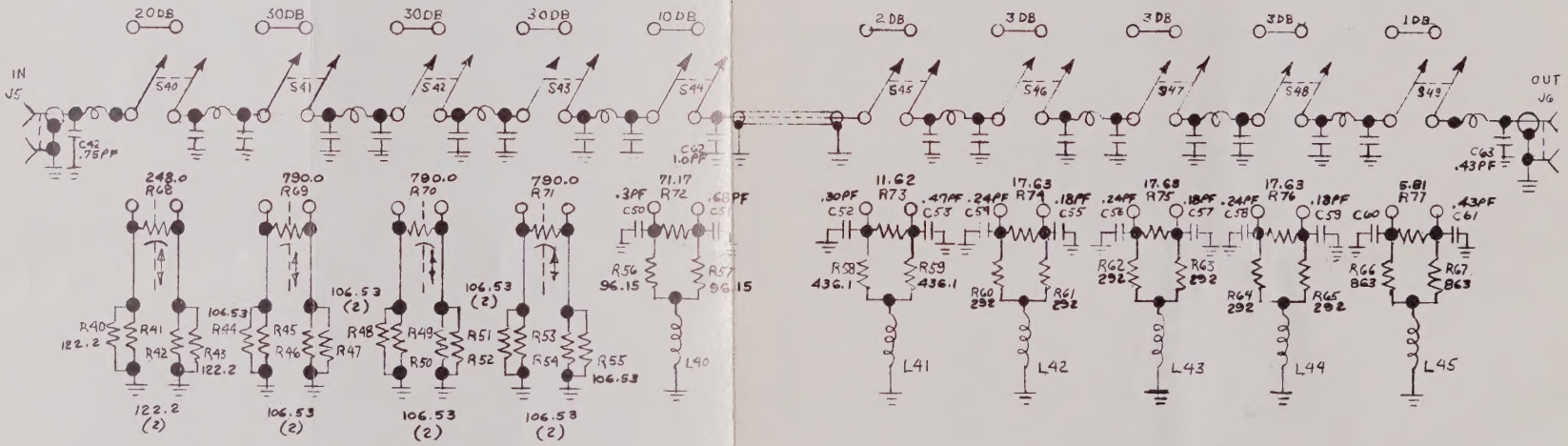
NOTE 2

CAVITY INDUCTANCE & CAPACITANCE INDICATED

NOTE 3

C30 THRU C41 & L10 THRU L14 MAY BE OMITTED FROM SOME UNITS

DWG. NO. 11112, ATTENUATOR MODEL 467



NOTE 1

SCHEMATIC FOR ATTENUATOR
MODEL NO 4647 50Ω 0 INSERTION LOSS

NOTE 2

CAVITY INDUCTANCE & CAPACITANCE INDICATED

NOTE 3

C40 THRU C64 & L40 THRU L45 MAY BE OMITTED FROM SOME UNITS

DWG. NO. 11389, ATTENUATOR MODEL 4647